support being relatively movable to bring the conduits into alignment with different regions.

REMARKS

This is a 371 Application of PCT/GB00/01829. A copy of the published application (WO 00/70129) is attached. Claims 2-5, 9-10, 12-13, 15, 19-23 are being amended in this Preliminary Amendment to eliminate multiple dependencies. Claim 23 has also been amended to better reflect its dependency on claim 17.

Respectfully submitted,

David Slone

Dated: 10/19/01

David N. Slone
Reg. No. 28,572

TOWNSEND and TOWNSEND and CREW LLP
Two Embarcadero Center, 8th Floor
San Francisco, California 94111-3834
Telephone: (650) 326-2400
Facsimile: (650) 326-2422
PA 3177413 v1

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend claims 2-5, 9-10, 12-13, 15, 19-23 as follows. Note that claims 1, 6-8, 11, 14, 16-18, 24-26 remain unchanged, but are reproduced below, in smaller type and single-spaced, for the Examiner's convenience and reference.

1. (Unchanged) A method of epitaxially growing a material on a substrate, the method comprising separately heating precursors, at least two of which have different decomposition temperatures, to their respective decomposition temperatures at or adjacent a region of the substrate to generate species which are supplied separately in a sequential manner to the region and which combine at the region.

2. (Once Amended) A method according to claim 1 **[or claim 2]**, wherein the species are supplied separately to the region by the relative movement of the substrate to cause the movement of the region with respect to the locations at which decomposition of the precursors occurs.

3. (Once Amended) A method according to **[any of the preceding claims,]** <u>claim 1</u>, wherein at least one precursor is supplied separately to the region as a gas stream.

4. (Once Amended) A method according to **[any of the preceding claims,]** <u>claim 1</u>, wherein the species are chosen from the Group III and Group V elements.

5. (Once Amended) A method according to **[any of claims]** <u>claim</u> 1, **[to 3]** wherein the species are chosen from the Group IV elements.

6. (Unchanged) A method according to claim 4, wherein the species comprise Gallium and Nitrogen.

7. (Unchanged) A method according to claim 5, wherein the species comprise Carbon and Silicon.

8. (Unchanged) A method according to claim 6, wherein one of the precursors is ammonia.

9. (Once Amended) A method according to **[any of the preceding claims,]** <u>claim 1</u>, wherein the substrate comprises a semiconductor such as Gallium-Arsenide.

10. (Once Amended) A method according to **[any of the preceding claims,]** <u>claim 1</u>, wherein one of the precursors is heated to its decomposition temperature by heating the substrate.

11. (Unchanged) A method according to claim 10, wherein the substrate is heated to the decomposition temperature of the precursor with the lower decomposition temperature.

12. (Once Amended) A method according to claim 10 **[or claim 11]**, wherein the substrate is heated to a temperature in the range 550-800°C.

13. (Once Amended) A method according to **[any of the preceding claims,]** <u>claim 1,</u> wherein one of the precursors is heated to its decomposition temperature at a location adjacent the region.

14. (Unchanged) A method according to claim 13, wherein the precursor is heated to a temperature in the range 400-1800°C.

15. (Once Amended) A method according to **[any of the preceding claims,]** <u>claim 1</u>, further comprising moving the region across the substrate.

16. (Unchanged) Apparatus for epitaxially growing a material on a substrate, the apparatus comprising a chamber containing a substrate support, the chamber having a first inlet for supplying a first precursor and a second inlet, separate from the first inlet, for supplying a second precursor, the first and second precursors having different decomposition temperatures; and first and second heating means for separately heating the first and second precursors to their respective decomposition temperatures at or adjacent a region of the substrate to generate species which are supplied separately in a sequential manner to the region and which combine at the region.

17. (Unchanged) Apparatus according to claim 16, wherein the second inlet is formed in a supply conduit located adjacent the substrate support.

18. (Unchanged) Apparatus according to claim 17, wherein the second inlet is in the form of an elongate slot.

19. (Once Amended) Apparatus according to **[claim 17 or]** claim 18, wherein the second heating means is provided in or adjacent the slot.

20. (Once Amended) Apparatus according to **[any of claims]** <u>claim</u> 16 **[to 19]**, wherein the second heating means is in the form of a heating wire.

21. (Once Amended) Apparatus according to **[any of claims]** claim 16 **[to 20]**, wherein the first heating means is located at a position to heat the substrate support.

22. (Once Amended) Apparatus according to **[any of claims]** claim 16 **[to 21]**, further comprising means for causing relative movement between the substrate support and at least one of the inlets.

23. (Once Amended) Apparatus according to **[claim 22, when dependent on at least]** claim 17, further comprising means for causing relative movement between the substrate support and at least one of the inlets, wherein a plurality of supply conduits are provided for supplying the same or different precursors to regions on the substrate, the conduits and substrate support being relatively movable to bring the conduits into alignment with different regions.

24. (Unchanged) Apparatus according to claim 23, wherein the supply conduits are arranged to supply precursors separately and sequentially to the region.

25. (Unchanged) Apparatus according to claim 22 wherein the relative movement between the substrate support and at least one of the inlets is in a transverse manner.

26. (Unchanged) Apparatus according to claim 22 wherein the relative movement between the substrate support and at least one of the inlets is in a rotational manner.

undesirable reactions in the mixture which reduce the overall efficiency of the process.

EP-A-0683249 discloses apparatus for independently supplying cation and anion material gases to a substrate using a rotating substrate holder.

In accordance with one aspect of the present invention a method of epitaxially growing a material on a substrate comprises separately heating precursors, at least two of which have different decomposition temperatures, to their respective decomposition temperatures at or adjacent a region of the substrate to generate species which are supplied separately in a sequential manner to the region and which combine at the region.

In contrast to the known methods, we separately heat the precursors to their respective decomposition temperatures at or adjacent this region, the region constituting a growth region in which the species combine. In this way, each precursor can be heated to its most efficient decomposition (cracking) temperature, while carrying out this process adjacent to the region minimises the risk of nascent atoms recombining before reaching the substrate surface.

The species formed by the decomposition of the precursors are highly reactive and rapidly form more stable products. The probability of a species being involved in further reactions is a function of time and concentration. By decomposing the precursors in the vicinity of the growth region, the species formed are encouraged to combine at the growth region on the substrate, rather than forming undesirable reaction products. The decomposition of the precursors in close proximity to the growth region reduces the time period in which unfavourable reactions can occur.

Preferably the species from each precursor are supplied separately to the region in a sequential manner. The species may be supplied separately to the region by moving the substrate, to cause the movement of the region with respect to the locations at which decomposition of the

precursors occurs. Typically, at least one of the precursors will be supplied separately to the region as a gas stream.

Preferably the species may be chosen from the Group III and Group V elements. Alternatively the Group IV elements may be used such as Silicon and Carbon.

In the preferred example, one of the precursors, preferably the one with the lowest decomposition temperature, is heated to its cracking temperature by heating the substrate. In this preferred example, another of the precursors is heated to its cracking temperature at a location adjacent the region. Thus, the substrate could be heated in the range 550-800°C, for example 650°C, while the other precursor is heated to its optimum cracking temperature either directly or in the presence of a catalyst. Typically this temperature is in the range 400-1800°C.

In accordance with a second aspect of the present invention, apparatus for epitaxially growing a material on a substrate comprises a chamber containing a substrate support, the chamber having a first inlet for supplying a first precursor and a second inlet, separate from the first inlet, for supplying a second precursor, the first and second precursors having different decomposition temperatures; and first and second heating means for separately heating the first and second precursors to their respective decomposition temperatures at or adjacent a region of the substrate to generate species which are supplied separately in a sequential manner to the region and which combine at the region.

Preferably, the second inlet is formed in a supply conduit located adjacent to the substrate support. This provides a convenient way of bringing the second precursor close to the substrate.

The second inlet can take a variety of forms including for example a circular hole or the like but is preferably in the form of an elongate slot.

The second heating means is conveniently provided in or adjacent the slot although it could be spaced upstream of the slot.

The supply conduit will typically be made of a refractory material such as quartz, SiN or alumina while

CLAIMS

1. A method of epitaxially growing a material on a substrate, the method comprising separately heating precursors, at least two of which have different decomposition temperatures, to their respective decomposition temperatures at or adjacent a region of the substrate to generate species which are supplied separately in a sequential manner to the region and which combine at the region.

2. A method according to claim 1 or claim 2, wherein the species are supplied separately to the region by the relative movement of the substrate to cause the movement of the region with respect to the locations at which decomposition of the precursors occurs.

3. A method according to any of the preceding claims, wherein at least one precursor is supplied separately to the region as a gas stream.

4. A method according to any of the preceding claims, wherein the species are chosen from the Group III and Group V elements.

5. A method according to any of claims 1 to 3, wherein the species are chosen from the Group IV elements.

6. A method according to claim 4, wherein the species comprise Gallium and Nitrogen.

7. A method according to claim 5, wherein the species comprise Carbon and Silicon.

8. A method according to claim 6, wherein one of the precursors is ammonia.

9. A method according to any of the preceding claims, wherein the substrate comprises a semiconductor such as Gallium-Arsenide.

10. A method according to any of the preceding claims, wherein one of the precursors is heated to its decomposition temperature by heating the substrate.

11. A method according to claim 10, wherein the substrate is heated to the decomposition temperature of the precursor with the lower decomposition temperature.

12. A method according to claim 10 or claim 11, wherein the substrate is heated to a temperature in the range 550-800°C.

13. A method according to any of the preceding claims, wherein one of the precursors is heated to its decomposition temperature at a location adjacent the region.

14. A method according to claim 13, wherein the precursor is heated to a temperature in the range 400-1800°C.

15. A method according to any of the preceding claims, further comprising moving the region across the substrate.

16. Apparatus for epitaxially growing a material on a substrate, the apparatus comprising a chamber containing a substrate support, the chamber having a first inlet for supplying a first precursor and a second inlet, separate from the first inlet, for supplying a second precursor, the first and second precursors having different decomposition temperatures; and first and second heating means for separately heating the first and second precursors to their respective decomposition temperatures at or adjacent a region of the substrate to generate species which are supplied separately in a sequential manner to the region and which combine at the region.

17. Apparatus according to claim 16, wherein the second inlet is formed in a supply conduit located adjacent the substrate support.

18. Apparatus according to claim 17, wherein the second inlet is in the form of an elongate slot.

19. Apparatus according to claim 17 or claim 18, wherein the second heating means is provided in or adjacent the slot.

20. Apparatus according to any of claims 16 to 19, wherein the second heating means is in the form of a heating wire.

21. Apparatus according to any of claims 16 to 20, wherein the first heating means is located at a position to heat the substrate support.

22. Apparatus according to any of claims 16 to 21, further comprising means for causing relative movement between the substrate support and at least one of the inlets.

23. Apparatus according to claim 22, when dependent on at least claim 17, wherein a plurality of supply conduits are provided for supplying the same or different precursors to regions on the substrate, the conduits and substrate support being relatively movable to bring the conduits into alignment with different regions.

24. Apparatus according to claim 23, wherein the supply conduits are arranged to supply precursors separately and sequentially to the region.

25. Apparatus according to claim 22 wherein the relative movement between the substrate support and at least one of the inlets is in a transverse manner.

26. Apparatus according to claim 22 wherein the relative movement between the substrate support and at least one of the inlets is in a rotational manner.